PATENT SPECIFICATION

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(54) TURBINE

(71) We, RHONE-POULENC-TEXTILE, a French Body Corporate, of 5 Avenue Percier, Paris 8e, France, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a turbine employing a gaseous fluid. It relates more particularly to a turbine intended to revolve at high speed. By "high speed", there are to be understood speeds of several thousands of revolutions per minute and speeds which can be as high as 100,000 revolutions/minute.

A turbine of this type, which generally uses compressed air, consists essentially of a bladed wheel, each blade having a particular profile to give the best result, and of one or more fluid inlet nozzles which direct at least one jet of fluid under pressure onto the blades, at a particular angle, the deflection of the jet producing the thrust. The jet of fluid can be dispensed from the nozzle to the blades via a volute-shaped channel, of decreasing depth, which surrounds the bladed wheel over a part of its periphery. This applies to the turbine described in French Patent 1,063,861.

Attempts have been made to use turbines in the textile industry, for example to rotate spindles on which a yarn coil support is mounted.

However problems are encountered in use. One of these relates to the operating noise which manifests itself very particularly when the turbine is supplied with jets of fluid discharged at supersonic speed, which is the case when the pressure of the fluid is high. The turbines can then emit a sound, the frequency and intensity of which rapidly make it intolerable. This noise problem would thus tend greatly to restrict the use of the turbine.

Other problems arise, particularly within the field mentioned above of using a turbine to rotate a spindle carrying a textile yarn coil support, the yarn winding being moreover in peripheral contact with a pilot roller which imparts to it a constant peripheral speed. As the coil increases in size, the angular speed decreases, as does the speed of the turbine. The turbine must thus possess a graph of the torque as a function of its rotational speed which is as close as possible to the graph of the torque which resists the winding-up process.

The turbines which are best suited to this function are "high pressure" turbines, that is to say turbines which are supplied with fluid under relative pressures of 3 to 8 bars and more; these turbines possess a flat torque graph.

On the other hand, in general terms, high pressure turbines possess the disadvantage of a mediocre output, mainly at low and average speeds. Moreover, construction problems can be encountered due to the small dimensions of a turbine used to drive a winding-up spindle.

According to the present invention we provide a turbine employing a gaseous fluid, comprising a bladed wheel positioned in a circular seat formed in a turbine body and at least one fluid inlet nozzle mounted in the said turbine body, the circular seat having the same number of part circumferential grooves as there are fluid inlet nozzles, the depth of the grooves decreasing substantially to zero in going from the fluid inlet nozzle to a peripheral contact zone between the bladed wheel and the circular seat, this zone forming a leakproof zone and being situated upstream from the next fluid inlet nozzle, each blade of the bladed wheel having a low pressure side extending initially substantially in the direction of a jet issuing from the fluid inlet nozzle and a high pressure side making an angle initially of less than 20° with this jet, the angle of taper (as hereinafter defined) of each blade being less than 20° and the outline of the blade at its tip being convex on both said sides.

The turbine according to the invention is advantageously supplied by a gaseous fluid under high pressure, that is to say the pressure of which is substantially between 3 and 8 bars.

Preferably, the low pressure and the high pressure sides, are each extended by an arc of a circle which extends over at least 140°.

Each circumferential groove, which will also be denoted by "inter-blade dispensing channel", makes it possible for the fluid to be fed to several blades simultaneously. The leakproof zone is preferably shorter than the groove, and the fluid is thus fed to the majority of the blades simultaneously.

By "angle of taper", there is to be understood that angle made between the tangent to the high pressure side of the blade and the tangent to the low pressure side of the blade, such that these two pressure sides form a tip of the blade. Since the outline of each blade is convex on both said sides in such a way that the jet issuing from the fluid inlet nozzle is tangential to the low pressure side of the profile and attacks the high pressure side at a small angle, of less than 20°, a funnel-shaped inlet for the fluid is thus produced between the low pressure side and the high pressure side of two successive blades. Since the high pressure and the low pressure side are each extended by an arc of a circle which extends over at least 140°, a part annular narrow channel which produces a fluid deflection of at least 140° is thus formed between two successive blades.

The characteristic angle of taper makes it possible to minimise the impact shock of the jet on the leading edge and the losses in energy which it causes. Likewise, as the outline is convex on both sides, and the high and low pressure sides of each blade are as described it is possible to collect the jet whilst avoiding the large losses in energy due to the impacts which would occur if the angle of incidence were large. Furthermore, if the high and low pressure sides are extended by an arc of a circle extending over at least 140° it is possible to obtain a large deflection of the jet of fluid under pressure necessary to achieve a good output.

These characteristics together make it possible to obtain a good output of the turbine supplied under high pressure. However, especially, it has been noted that the combination of these characteristics with the method of dispensing via inter-blade channels, makes it possible to reduce the operating noise to a large extent, the sound level being thus brought back to well below the acceptable limit.

The angle of injection is preferably between 80 and 90° this angle being the angle which the geometric axis of the injector makes with a radius of the bladed wheel at the injector. The injectors are thus positioned parallel and near to a tangent of the circular seat.

In order that the invention will be better understood, the following description is given merely by way of example, reference being made to the accompanying drawings, in which:—

Figure 1 is an end elevation in cross-section along the line *b—b* of Figure 2 of a turbine body of one embodiment of turbine according to the invention;

Figure 2 is a section along the line *a—a* of Figure 1;

Figure 3 is an axial cross-sectional view of a turbine according to Figures 1 and 2;

Figure 4 is a view showing the profile of the bladed wheel of a turbine according to the invention; and

Figure 5 represents the sound spectrum of a turbine according to the invention and the sound spectrum of a turbine of conventional type.

The turbine represented in Figure to 4 comprises a turbine body 1, the general shape of which is substantially circular and which has a circular seat 2 for a bladed wheel. The turbine body 1 is equipped to receive two fluid inlet nozzles mounted in cylindrical seats 3 and 4 spaced circumferentially 180° apart. The seats 3 and 4, and consequently the nozzle, are positioned parallel to and nearby a tangent to the circular seat 2. The angle of injection α is thus 90°. The circular seat 2 is equipped with two circumferential grooves 5 and 6 each of which extend substantially over an arc of 155° from the outlet of the seats 3 and 4 respectively in the circular seat 2 to a leakproof zone 7 which extends over an arc of 25°. The depth of each groove decreases uniformly in the direction of flow of the fluid, that is to say starting from the nozzle, and decreases to zero at the end of the groove. Each circumferential groove which as can be seen in Figures 2 and 3, has a semi-circular profile in cross-section, forms an inter-blade dispensing channel, the said channel making it possible for the fluid to be fed to several blades simultaneously. The fluid is dispensed to the nozzles via a peripheral dispensing channel 17 supplied by a feed pipeline 18. The fluid escapes from the turbine through an exhaust muffler 19 which, in a known manner, consists of porous materials.

The bladed wheel 8, represented in Figure 4, comprises thirty blades 9, the profile of which is represented in the figure. The leading edge 10 has a small angle, taper angle A, of substantially 20°. The outline of the profile is convex on both faces. The low pressure side 11 possesses a slightly curved portion, extended by a straight portion. The high pressure side 12 has a more accentuated curve, in the opposite direction. The arrangement of the profile is such that the jet which issues from the

nozzle, at an angle of injection of 90°, is tangential to the low pressure side and attacks the high pressure side at a low angle of at most 20°. A funnel-shaped inlet 13 which collects the jet is thus defined between two blades 9 and 91. The profile is completed both on the low pressure side and on the high pressure side by an arc of a circle 14—15 which extends over 140°. A circular channel 16 which causes a 140° deflection of the fluid is thus formed between two blades 9 and 91.

In Figure 3, the bladed wheel 8 has been represented firmly fixed to a spindle 20 with which it must rotate. The spindle 20 is intended to receive a textile yarn coil support.

Example

A turbine according to Figures 1 to 4, the wheel of which possesses 30 blades and has a diameter of 90 mm, is used to drive a spindle intended to receive a textile yarn coil support. The operating noises are analysed; the spectrum set up in a sound-proof chamber is recorded on a Bruel and Kjoer apparatus. The working conditions are as follows:

Injection fluid:	Compressed air,
pressure (read on a manometer):	4.2 bars,
speed:	480 metres/second,
output via the injector:	Approximately 2 grams/second,
turbine with two injectors, and rotational speed:	20,000 revolutions/minute.

Analysis of the noises yields the spectrum 21 given in Figure 5. In this Figure, the graph 24 represents the acceptable limit; the danger zone lies above the graph 23 and the safe zone lies below the graph 25. Only one point is observed above 80 decibels, emitted at a low frequency of approximately 330 Hertz and it remains within the limit of the acceptable threshold. However, this noise does not arise from the turbine but from the ball bearings, and corresponds to the frequency of the spindle. The overall sound level, integrated from 0 to 20,000 Hertz, is 82.5 Db, that is to say 77 Db.A.

By way of comparison, the noises from a turbine equipped with an identical bladed wheel mounted in a turbine body, the seat of which does not possess any circumferential groove, have been analysed. The angle of injection is 70° and a single fluid inlet nozzle is used. The working conditions are as follows:

Injection fluid:	Compressed air,
pressure (read on a manometer):	5 bars,
speed:	480 metres/second,
output:	2 grams/second, and
rotational speed:	21,000 revolutions/minute.

Analysis of the noises gives the spectrum 22 represented in Figure 5. Up to approximately 1,800 Hertz, the graphs 21 and 22 are substantially identical. Thereafter, the two graphs are markedly different. For frequencies of 0 to 20,000 Hertz, an overall level of 94.5 Db, that is to say, 91 Db.A., is obtained. Above all, a point of 83 Db at a frequency of approximately 5,200 Hertz and a point of 90 Db at approximately 10,500 Hertz are recorded. The latter point, lying in the danger zone, is particularly painful; it rapidly becomes intolerable.

The turbine according to Figures 1 to 4, with a bladed wheel of diameter 90 mm, supplied under the conditions of the example, provides a power of 90 watts, at 16,000 revolutions/minute; the overall efficiency reaches 0.2. At 30,000 revolutions/minute by increasing the number of fluid inlet nozzles this same turbine makes it possible to develop powers which can be as high as 750 watts and still operates silently. However, this value does not constitute a limit and it is possible to achieve higher powers and speeds.

The above example shows the progress made by the turbine according to the invention, combining a turbine body with a circumferential groove and a wheel with blades with a special profile. The great reduction in operating noises makes it possible to use the turbine, whilst previously it was difficult to consider its use. The power developed by the turbine, taking its overall size into account, is perfectly compatible with numerous uses such as driving a spindle for winding-up a textile yarn. The output can be considered to be acceptable.

Of course, the invention is not limited to the example described but can comprise variants, particularly with regard to the number of fluid inlet nozzles and circumferential grooves, the shape of the cross-section of these grooves, the diameter

of the turbine, the number of blades and the like.

It can be applied to rotating any component which has to revolve at high speed. It is particularly suitable for driving spindles intended to receive a textile yarn coil support.

WHAT WE CLAIM IS:—

1. A turbine employing a gaseous fluid, comprising a bladed wheel positioned in a circular seat formed in a turbine body and at least one fluid inlet nozzle mounted in the said turbine body, the circular seat having the same number of part circumferential grooves as there are fluid inlet nozzles, the depth of the grooves decreasing substantially to zero in going from the fluid inlet nozzle to a peripheral contact zone between the bladed wheel and the circular seat, this zone forming a leakproof zone and being situated upstream from the next fluid inlet nozzle, each blade of the bladed wheel having a low pressure side extending initially substantially in the direction of a jet issuing from the fluid inlet nozzle and a high pressure side making an angle initially of less than 20° with this jet, the angle of taper (as hereinbefore defined) of each blade being less than 20° and the outline of the blades at its tip being convex on both said sides.

2. A turbine according to claim 1, wherein the low pressure and the high pressure sides are each extended by an arc of a circle which extends over at least 140°.

3. A turbine according to claim 2, wherein both faces of each blade include a substantially straight portion between the convex portion at the tip and the arc of the circle.

4. A turbine according to claim 1, 2 or 3, wherein the angle of injection of said nozzles is between 80 and 90 degrees to a radius of the bladed wheel at the outlet of the injector.

5. A turbine substantially as hereinbefore described with reference to and as illustrated in Figures 1 to 4 of the accompanying drawings.

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1474134 COMPLETE SPECIFICATION

4 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

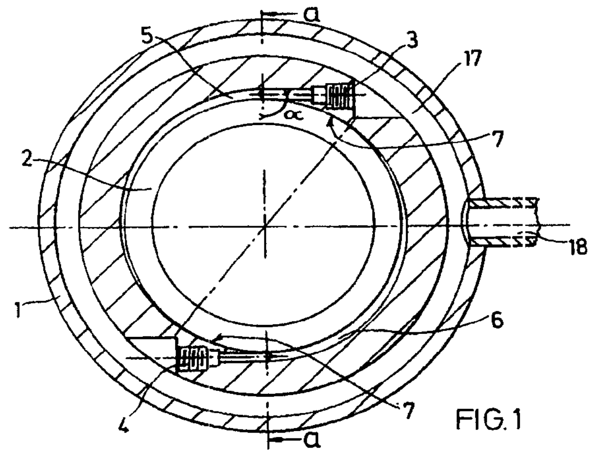


FIG.1

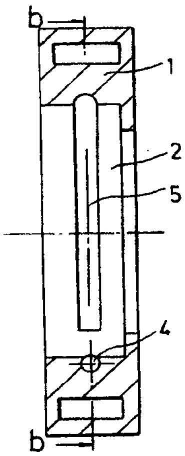


FIG.2

1474134 COMPLETE SPECIFICATION

4 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 2

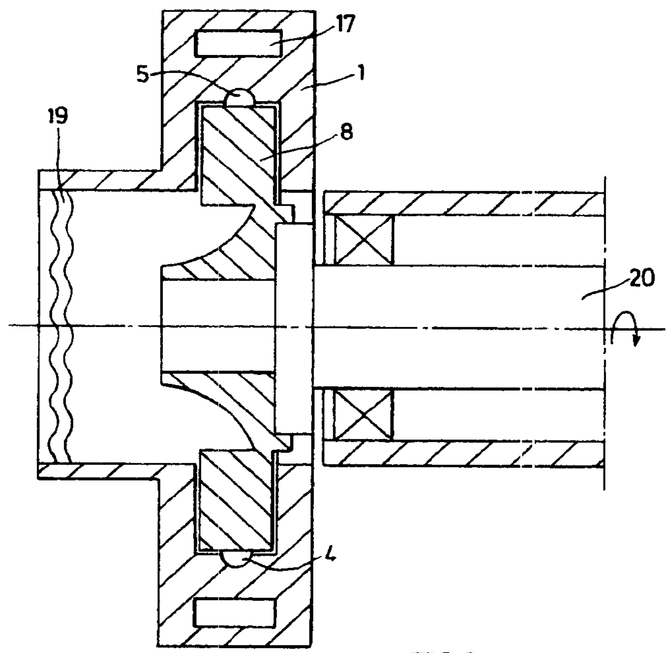


FIG.3

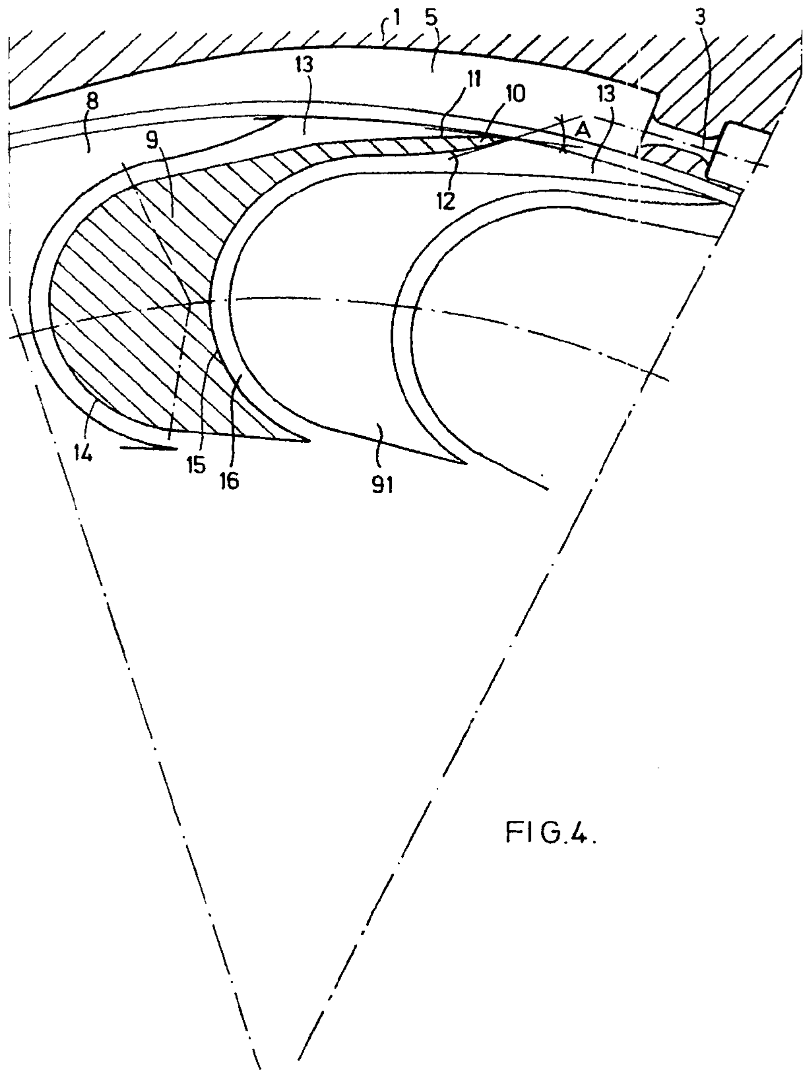
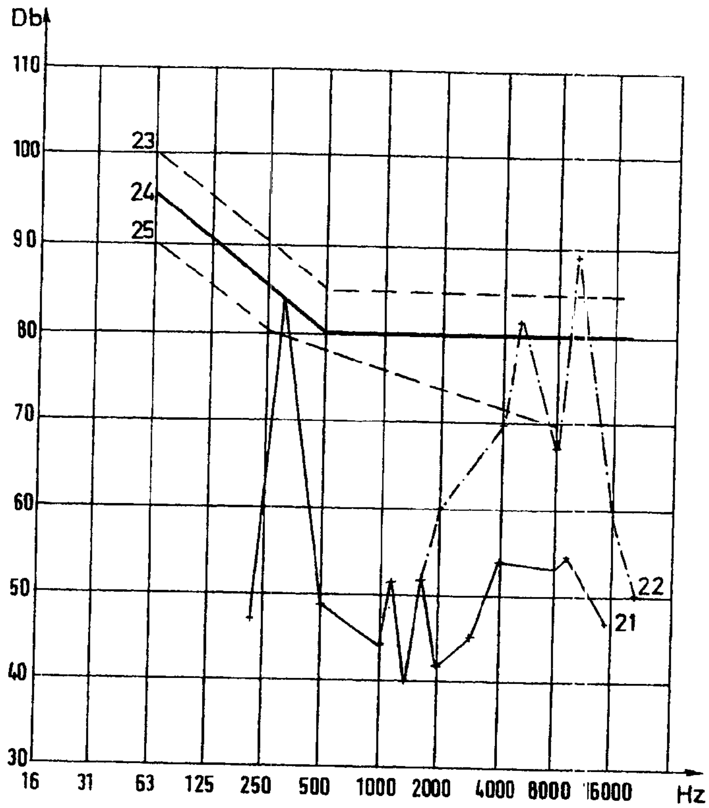


FIG.4.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